



Importance of Records

Plant analysis reports provide valuable data for making management decisions. Growers can reduce application rates and fine tune fertilizer programs to address hidden hunger without sacrificing yield or quality. Compiling yield data with plant reports provides essential records of nutrient use in waste management systems. Plant analysis reports can serve as valuable evidence of responsible crop management and environmental stewardship.

For additional information, contact

NCDA&CS Agronomic Division
Plant/Waste/Solution Section

Physical Location:
4300 Reedy Creek Road
Raleigh, NC 27607-6465

Mailing Address:
1040 Mail Service Center
Raleigh, NC 27699-1040

Phone: (919) 733-2655

Web site:
www.ncagr.com/agronomi/

prepared by
C. Ray Campbell, retired
Brenda Cleveland
& C. C. Carter

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Agronomic Division

Plant Tissue Analysis



*Improving Agriculture
& Protecting the Environment*

N.C. Dept. of Agriculture
& Consumer Services

Healthy plants contain predictable concentrations of essential elements. Growers who submit plant tissue samples for analysis can monitor actual levels of these elements within a crop throughout the season. They can discover deficiencies or toxicities, even before visible symptoms are present. As a result, they can optimize fertilization in a timely manner.

The Agronomic Division chemically analyzes plant tissue samples, interprets the results, and provides management advice. The analysis measures existing concentrations of nutrients required for plant growth, including major nutrients (N, P, K), secondary nutrients (Ca, Mg, S), and micronutrients (Fe, Mn, Zn, Cu, B, Mo, Cl). If necessary, potentially toxic elements—such as Al, Cd, Li, Na, Ni, and Pb—can also be measured.



Plant Analysis & Soil Testing

Many growers test soils regularly and apply fertilizer based on the results. The ones who conscientiously do this may question the usefulness of plant analysis. Although soil testing and plant tissue analysis both measure nutrient status, each provides different benefits that can complement each other.

Soil testing measures levels of specific nutrients in the soil. It does not indicate if the plants growing in that soil are able to retrieve those nutrients. Also, it is not a reliable indicator of nutrients that leach readily from the soil—such as nitrogen or sulfur—or of certain micronutrients. It is, however, the best way to assess soil pH.

Plant tissue analysis measures all essential plant nutrients and indicates whether the sample tissue contains an adequate concentration at the current time. Alone it does not provide enough information to explain why nutrient levels may be high or low.

Together, soil testing and plant tissue analysis form a powerful tool for assessing nutrient problems. With plant analysis, agronomists can pinpoint the fertilizer needs of a crop and make precise recommendations that are environmentally sound. Growers can then maximize crop yield and quality while protecting land and water resources.



Applications in North Carolina

Plant tissue analysis can be used to (1) monitor plant nutrient status or (2) diagnose existing nutrient problems. Monitoring involves sampling healthy crops to fine-tune fertilization strategy and identify nutrient deficiencies/toxicities that may be present but not yet visible. Diagnostic analysis involves taking samples from unhealthy or discolored plants to find out if any nutrient concentrations are too high or too low.

Monitoring Nutrient Status

Growers can monitor the nutrient status of healthy crops to identify changes in nutrient needs as the growing season progresses. In the coastal plain, rainfall can leach nutrients—such as sulfur, nitrogen, and, to a lesser extent, potassium—out of the root zone. By taking tissue samples regularly, growers can correct nutrient problems before symptoms appear.

Monitoring nutrient status is most profitable for high-value, intensively managed crops like cotton, tobacco, fruits, and vegetables. Adjustments to fertilization based on samples collected weekly or biweekly throughout the fruiting season have a major impact on final yields. For less valuable crops like corn, tissue analysis is used less frequently and more as a source of information for long-term planning and refinement of existing fertilizer programs.

Diagnosing Nutrient Problems

To diagnose nutrient deficiencies or toxicities, follow this procedure:

- 1) take separate tissue samples from plants that are growing well and those that are not and
- 2) take matching soil samples from root zones of each group of plants.

Soil samples supplement tissue samples by providing information on nutrient availability, pH, and soluble salts. Comparison of the two samples can indicate whether other factors, such as insect and disease damage or drought stress, are involved.

Finally, plant tissue analysis supports responsible land stewardship. Plants respond to increasing levels of nutrients until maximum growth or yield has been

achieved. After that point, efficiency of growth decreases and environmental risks increase. Plant tissue analysis is a useful tool for avoiding environmental damage due to excess nutrient loading.



Sampling Procedures

With plant tissue analysis, reliable results depend on collecting the best indicator samples. Uniformity of sampling enhances reliability of results. The best time to take samples is between mid-morning and mid-afternoon, avoiding rain events. Samples should be kept free of soil contamination.

Best Indicator Samples

Taking a tissue sample depends on the crop, its stage of growth, uniformity of growth, and the purpose of sampling. The most recent mature leaf (MRML) is usually the best indicator of nutritional status. The MRML is the first fully expanded leaf back from the growing point. It is neither shiny green from immaturity nor dull from age.

When sampling evergreen trees or ornamentals, take mature needles from the most recent flush of growth, generally from the upper third of the plant. For fine turf or lawn grasses, use mower clippings. A double handful is adequate if it is representative of the area sampled. For forage grasses and small grains, take the top three to four leaves or inches of growth.

Some crops—including cotton, strawberry, and grape—require a more precise measurement of nitrate nitrogen (NO₃-N) than leaves alone can provide. When sampling these crops, include petioles with the MRML samples. Detach the petioles from the leaves as you collect the samples. Place the petioles in a small separate envelope. Put the MRMLs and the envelope of petioles together inside a larger envelope or paper container.

When symptoms appear in different zones on a plant, take a separate sample of the affected tissue in

addition to the MRML. In this case, comparative samples of the same tissue from symptom-free plants are also helpful in isolating very small differences between the two areas.

Sample Size

The sample should contain enough leaves to represent the average condition of the crop. Ten to 15 leaves is an adequate sample for most crops.

For large-leaved crops like tobacco, a sample may consist of as few as four representative leaves. For small-leaved plants like azalea, a good sample contains 25 to 30 leaves. For crops that will have petioles analyzed separately, a minimum of 15 to 20 leaves is needed.

For young seedlings with very small MRMLs, take the whole above-ground portion of 30 or more plants. For plants taller than 3 inches, the MRML is a better indicator of nutritional status.

Sample Packaging

Paper containers, like lunch bags or the envelopes provided by the Agronomic Division, are good for tissue samples. Never place plant samples in plastic containers because they trap moisture. The resulting high humidity promotes growth of fungi and bacteria and accelerates deterioration of the samples.

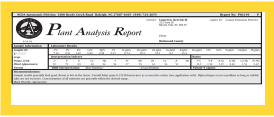
When several individual samples are sent to the lab, all the envelopes should be placed loosely in a larger container clearly addressed to the Plant/Waste/Solution Section of the Agronomic Division. If matching soil samples are sent in the same container, make sure they do not contaminate the plant tissue.

Submitting Samples

Include a completed plant analysis information sheet and the appropriate processing fee with each sample sent to the Agronomic Division laboratory for tissue analysis. Indicate on the information sheet which type of analysis you want: predictive or diagnostic.

A “predictive” analysis gives a general nutrient assessment; a “diagnostic” analysis tries to identify the cause of a specific problem. For predictive samples, recommendations are computer generated.

For diagnostic samples, agronomists review the lab results and provide specific recommendations.



Plant Analysis Report

The plant analysis report has three sections: laboratory results, interpretation, and recommendations. Results include concentrations of essential plant nutrients and potentially harmful elements on a dry weight basis. Ratios of important elements, including N:K, N:S, and Fe:Mn, are also calculated. The nitrate nitrogen concentration of petioles is reported on a dry weight basis for crops requiring this precise prediction of nitrogen status.

Interpretation is based on sufficiency ranges established for each crop. Nutrient concentrations are converted to a standard index scale of 0 to 124 (Figure 1). The index scale is divided into interpretation zones.

Values in the sufficient range (50 to 74) indicate maximal growth or response. High values (75 to 99) indicate that nutrient levels are more than adequate and that luxury consumption may be occurring. Luxury consumption may not be detrimental to yield, but it can influence quality and production efficiency.

Index values in the low (25 to 49) or excess (100 to 124) ranges indicate that yield or growth may be depressed because too little or too much of an element is present. Within the deficient range (0 to 24), growth is severely depressed.

Nutrient concentrations below the critical value or above the mild toxicity point indicate that yield or growth may be reduced by 5 to 10 percent. Excess accumulation of some elements may decrease efficiency and point to environmental impact even though levels are not toxic to plants.

The Diagnosis and Recommendation Integrated System (DRIS) lists the six most needed elements from the greatest to the least limiting. DRIS interpretation and ratios of essential elements indicate balance among required nutrients. DRIS values also

support the sufficiency range interpretation. Letters indicate the status of essential elements and ratios: deficient (D), low (L), high (H), and excessive (E). Absence of a letter by an index value indicates that it is within the normal range. Nitrate nitrogen values are also labeled as low (L), high (H), or excessive (E).

Interpretation indexes indicate how the crop is expected to respond to additional fertilizer (Table 1). If the index > 74, nutrient levels are high or in excess and adding more fertilizer will not boost yield.

When appropriate, the plant analysis report contains fertilizer recommendations and supporting information. Diagnostic reports also provide site-specific suggestions for corrective action.

Table 1. Response to nutrient applications.

Index	Interpretation	Crop Response
0-24	deficient	high
25-49	low	medium
50-74	sufficient	low
75-99	high	none
100-124+	excess	none

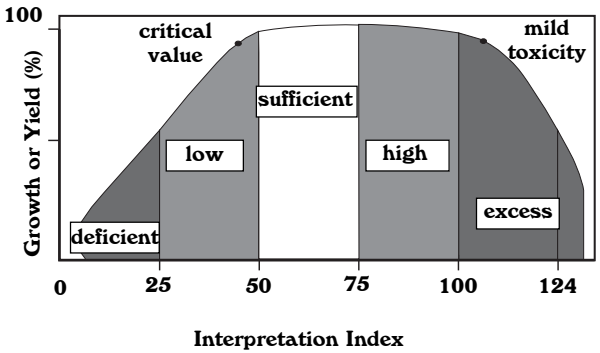


Figure 1. Interpretation indexes vs. growth or yield.